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Field trials for maximization of fish production in composite carp farming in mid hills of Uttarakhand

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Abstract
Present trials were undertaken to optimize fish stocking density, size, ratio and time of stocking in ponds to obtain maximum fish production in mid hill conditions. In experimental trial-1, fishes were stocked @ 100 (T1), 300 (T2), 500 (T3) and 700 no/100 m^2 (FP) ponds. Among the treatments, maximum fish growth was achieved in pond T1 (389.0 g) followed by T2 (297.5 g), T3 (186.65) and FP (123.85 g). However, highest fish production was achieved in Pond T2 (41.65 kg/100m^2) having fish stocking density 300 no/100 m^2 and lowest fish production was recorded in FP pond (27.82 kg/100m^2) at fish stocking of 700 no/100 m^2. In experimental trial-2, highest fish production (62.90 kg/100m^2) was recorded in ponds stocked with 10-12 cm size fish seed @ 300 no/100 m^2 in the ratio of 30:40:30 silver carp, grass carp and common carp, respectively, stocked in March and harvested after 12 month of growing period in February.

Keywords: aquaculture, composite carp farming, pelleted fish feed, pond productivity, stocking density

1. Introduction
India has made notable progress in fisheries during last few decades producing annually 10.79 million tonnes fish comprising 7.21 million tonnes from inland sector. About 80.0% of the inland fish produced in India is derived from aquaculture which is second largest in world aquaculture production [4]. However, Inspite of rich availability of water and fish resources, contribution of hill fisheries in total inland aquaculture production is negligible. Considering the vast and varied water resources, fish farming can play important role in providing cheaper protein rich food to rural poor in hill areas, since, majority of people residing in hills are non-vegetarian. The availability of fishes in natural waters is increasingly declining [7]. Therefore, attention is required on aquaculture for maximum exploitation of available water resources. Several attempts have been made to establish fish farming in cold water resources [8, 1]. Culture of native fishes such as mahseer and snow trout have not got desired success due to slow growth, non availability of fish seed and feed for these species(15). Farming of high valued trouts such as rainbow trout and brown trout have also not liked by the farmers due to its highly technical farming, high capital investment, non-availability of fish seed, fish feed and proper market. However, recently, carp farming comprising silver carp, grass carp and common carp in small earthen ponds have shown promising results realizing great scope of its standardization and promotion [5, 13]. Although, viability of composite carp farming technology is very well established through experiments conducted at various centers in different agro climatic conditions (except in mid hill conditions) in India [10]. Chauhan (2016) [2] has discussed about sustainable composite fish farming technology in hills. Therefore, in present trails, an attempt has been made to optimize density, size, ratio and time of stocking of fish seed in ponds to achieve maximum fish production under composite carp farming in mid hill areas.

2. Materials and Methods
Present trials were conducted in mid hill conditions (1200-1800 m asl) of Uttarakhand in district Champawatat farmers fields. In experimental trial-1, ponds (100 m^2 each) were drained and sun dried for about a month during May- June. Before stocking fish seed, ponds were filled with fresh water up to 1.25 m level, initially manured with cow dung @ 10 tonne/ha and lime was applied @ 200 kg/ha. Subsequently, manure was used @ 4 tonne/ha at monthly intervals except winter months (November to February) and lime @ 200kg/ha at alternate months in all the ponds. Fish seed (2-3 cm size) of silver carp, grass carp and common carp in the ratio of 40:30:30 was stocked @ 100 (T1), 300 (T2), 500 (T3) and 700 nos./100m^2 (Farmers practice-FP) area, each density in five ponds in the month of July (Table 1).
In experimental trial-2, ponds were prepared in the same way as in experimental trial-1 and stocked with silver carp, grass carp and common carp in the ratio of 40:30:30 (10-12 cm size) @ 300 nos./100m^2 area in the month of July in ponds T1 and in the ratio of 30:40:30 in ponds T2. In T3 ponds, fish stocking was same as in T2 ponds except they were stocked in the month of March (Table 2).
In both the experiments, fishes were fed once a day with pelleted fish feed having 26% protein (comprising rice bran, wheat bran, mustard oil cake, soybean oil cake and vitamin-mineral mixture) @ 1-3% body weight of fishes. Grass carp were fed with fodder grasses and vegetable waste twice a day. Observations were recorded on fish production in different treatment ponds and data were subjected to statistical analysis using RBD as per the standard procedure described by Panse and Sukhatme (1985) [9].

Table 1: Fish stocking details in experimental trial 1.

Details	Experimental trials			
	T1	T2	T3	FP
Pond size (m^2)	100	100	100	100
Fish seed density (no/100 m^2)	100	300	500	700
Fish seed size (cm)	2-3	2-3	2-3	2-3
Fish species ratio (S:G:C)	40:30:30	40:30:30	40:30:30	40:30:30
Time of stocking	July	July	July	July
Time of harvesting (crop duration in months)	June (12)	June (12)	June (12)	June (12)

Table 2: Fish stocking details in experimental trial 2.

Details	Experimental trials		
	T1	T2	T3
Pond size (m^2)	100	100	100
Fish seed density (no/100 m^2)	300	300	300
Fish seed size (cm)	10-12	10-12	10-12
Fish species ratio (S:G:C)	40:30:30	30:40:30	30:40:30
Time of stocking	July	July	March
Time of harvesting (crop duration in months)	June (12)	June (12)	February (12)

3. Results and Discussion

Experimental trial 1 was conducted to standardize the stocking density of fish seed in the ponds. Fish seed (2-3cm size) was stocked at different densities i.e. @ 100, 300, 500 and 700 no/100m^2 in ponds T1, T2, T3 and FP (farmers practice), respectively, in the month of July at species ratio of 40% silver carp, 30% grass carp and 30% common carp in all the ponds. Fishes were harvested after 12 months of rearing period in June. Perusal of Table 3 revealed that maximum average fish growth (389.23 g) was achieved in pond T1, in which stocking density of fish seed was lowest i.e. 100 no/100 m^2, whereas FP pond having highest fish stocking density i.e. 700 no/100 m^2 recorded lowest average fish growth (123.85 g). Inspite of higher average fish growth (389.23 g) and survival rate (65%) in pond T1, gross fish production was lowest i.e. 25.30 kg/100 m^2 which shows that stocking density 100 no/100 m^2 is less than the carrying capacity of fish ponds. On the other hand, stocking too much quantity of fish seed i.e. 700 no/100 m^2 in FP pond had resulted in poor survival (31.14%) and average fish growth (123.85 g), consequently, lower fish production i.e. 27.82 kg/100 m^2. Higher fish stocking density causes deterioration of water quality, increases carbon dioxide level and lower the pH level of pond water resulting low fish survival and production as also opined by Jena *et al.* (2001) [6] and Singh *et al.* (2003) [11]. Highest fish production 41.65 kg/100 m^2 in pond T2 suggested 300 no/100 m^2 is optimum density of fish seed for stocking in ponds located in mid hill areas. Tyagi and Joshi (2009) [14]. also reported better fish production at stocking density of 2.8-4.0 fish/m^2 in hill region.

Experimental trial 2 was conducted to optimize the stocking size, stocking ratio and time of stocking of fish seed. Lowest fish production i.e. 45.76 kg/100 m^2 with average growth of 305.08 g was recorded in pond T1 (Table 4) in which, 10-12 cm size fish seed was stocked @ 300 no/100m^2 in the month of July at the ratio of 40% silver carp, 30% grass carp and 30% common carp. Among the three species stocked in pond T1, grass carp grew at faster rate (389.0 g) followed by common carp (258.07 g). Regular supply of fodder grasses might have contributed in appreciable growth of grass carp because growth rate of grass carp is usually better in hill conditions [14]. The growth rate of silver carp was lowest (185.0 g) which may be due to the higher density (40%) of this species. Growth rate of silver carp in hill ponds is low due to poor pond productivity, consequently less plankton production which is preferred food of this species(13). Increasing the density of fast growing species grass carp from 30% to 40% and reduction of silver carp from 40% to 30% had improved the average fish growth (314.0 g) in pond T2, as a result, fish production was also better 48.68 kg/100 m^2 as compared to pond T1 (45.76 kg/100 m^2). Higher fish production (60-80 kg/100 m^2) with stocking greater proportion of grass carp seed (40-45%) in hill ponds have been reported by DCFR(3). On the other hand, only 20 kg/100m^2 fish production was registered with stocking fish seed having only 11% grass carp in lower hills of Nepal [1].

Highest fish production (62.90 kg/100 m^2) was recorded in pond T3, in which fishes were stocked at same size, species ratio as in pond T2 but stocked in the month of March and harvested after 12 month of growing period in February. Carp fishes grow faster in warm climate due to greater utilization efficiency of feed given to them [12]. Therefore, highest fish production in pond T3 could be attributed to the favorable warm climate received by fishes for longer duration (March to September) as compared to the fishes stocked in the month of July which experiences colder climate during most part of (October to Martch) crop duration.

4. Conclusion

It is inferred from the above results that highest fish production (62.90 kg/100 m^2) could be achieved by stocking 10-12 cm size fish seed @ 300no/100 m^2 at the ratio of 30% silver carp, 40% grass carp and 30% common carp and reared from March to February (12 month duration).

Table 3: Fish growth, survival and production details in experimental trial 1.

Details	Experimental trials				
	T1	T2	T3	FP	cd at 1%
Species wise fish growth (g)					
Silver carp	$253.0^{a,b}$	197.0^{c}	102.0^{b}	$73.0^{a,c}$	91.44
Grass carp	$550.0^{a,b}$	$430.0^{c,d}$	$275.0^{b,d}$	$195.0^{a,c}$	128.09
Common carp	$390.0^{a,b}$	310.0^{c}	210.0^{b}	$135.0^{a,c}$	127.15
Average fish growth (g)	389.23^{a}	297.50^{a}	186.65^{a}	123.85^{a}	45,47
Average fish survival (%)	$65.0^{a,b}$	$46.66^{a,b}$	34.60^{b}	31.14^{a}	4.29
Average fish production (kg/pond)	25.30^{b}	$41.65^{a,b}$	32.29^{b}	27.82^{a}	5.20
Fish production (kg/ha)	2530	4165	3229	2782	-

Figures having same superscript in each row are significantly different from each other at 1% level of significance

Table 4: Fish growth, survival and production details in experimental trial- 2.

Details	Experimental trials			
	T1	T2	T3	cd at 1%
Species wise fish growth (g)				
Silver carp	185.20[a]	193.6[b]	244.33[a b]	111.09
Grass carp	389.0[a]	385.0 [b]	403.93[c]	148.50
Common carp	258.07[a]	270.07[b]	305.73[a]	138.85
Average fish growth (g)	305.08[a]	314.08[b]	340.0[a]	52.84
Average fish survival (%)	49.33[a,]	51.66[b]	61.66 [a]	5.03
Average fish production (kg/pond)	45.76[a]	48.68[b]	62.90[a]	4.44
Fish production (kg/ha)	4576	4868	6290	-

Figures having same superscript in each row are significantly different from each other at 1% level of significance

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